**Characterizing trial-to-trial variability in MEG data**

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**Goal: Identify sources and magnitude of trial-to-trial variability**
- The brain is likely to react slightly differently on each trial even to the same stimulus, but MEG data contains so much noise it is difficult to analyze how trial-to-trial variations occur and how they may relate to behavior.
- To model single-trial evoked responses, which could vary in timing or amplitude, we need a way to characterize how large these variations are.
- Single-trial analysis is a fairly new idea in MEG with no dominant method, so the nature of this project is exploratory.
- Data is taken from a left-occipital sensor, centered around presentation of a visual stimulus (0 seconds), and measured in picoTeslas.

**Averaging across trials removes individual trial features**
- ~10 trials necessary to obtain an evoked response.
- Large variation in height and time of peaks.
- Subaverages of trials with the average across all evoked response is discernable at ~10 trials.

**Removing oscillatory trials and correcting latency variation strengthens evoked response in subaverages**
- Small change when shifting is performed without oscillatory trials and without cropping time (gray) compared to a time-crop version (red) indicates that we were able to successfully filter out enough oscillatory peaks that were previously skewing the results.

**Shifted and filtered data provides better estimates of variability**
- These would provide starting values for a hierarchical model describing single-trial variability.
- Removing problematic oscillatory trials and estimating single trial shifts obtained the distribution above- roughly symmetrical and centered at 0, with standard deviation 8.8 ms.

**Results**
- Averaging more quickly recovers the evoked response as we increase number of trials after removing oscillatory trials and performing shifts (red).
- By removing shift variation and outlier trials, we have removed some of the trial-to-trial variability.

**Conclusions**
- Types of trial-to-trial variability include latency and amplitude variation of evoked responses, in addition to ongoing activity before and after stimulus presentation and response.
- An outlier-corrected version of Woody’s original method was successful in aligning trials to remove much of the shift variation. It was also shown that the basic Woody filter can fail in this kind of data due to high-powered oscillations dominating some trials.
- By removing latency variation, we are better able to assess amplitude variation; however, taking a peak from each individual trial is still too noisy due to effects of ongoing activity- subaverages of 5 share information across trials to shrink estimates toward the mean to minimize influence of noise.
- Overall, this helps characterize the types of trial-to-trial variation present in MEG including estimates of shift and amplitude variance, which is helpful for further modeling of single trials.

**References**

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